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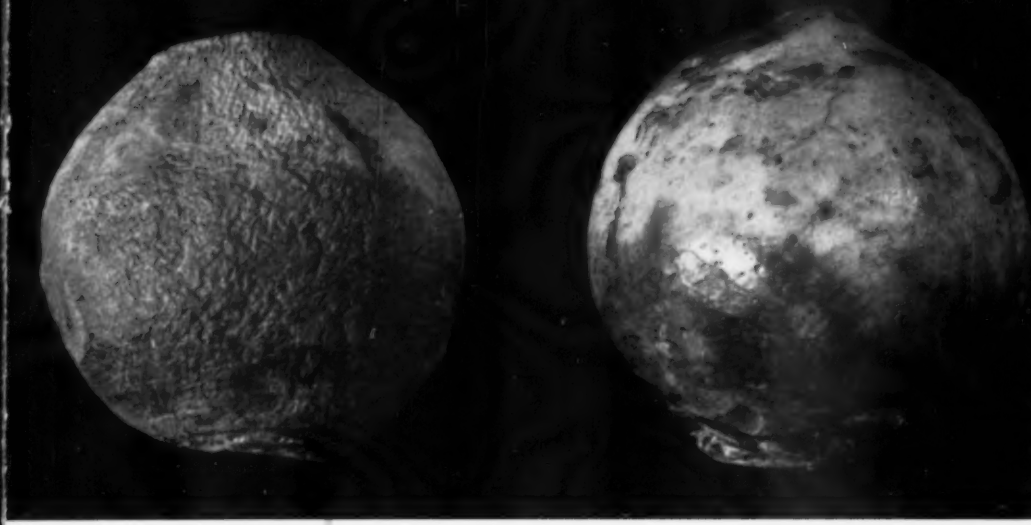


WAXING *Vegetables*

J. D. HARTMAN AND F. M. ISENBERG

Cover illustration

Rutabagas after nine days at 75° F. *Right*: waxed by paraffin-dip method, moisture loss 3 percent. *Left*: not waxed, moisture loss 29 percent

Waxing Vegetables

JOHN HARTMAN AND F. M. ISENBERG

VEGETABLES are waxed primarily to improve their lustre and to control shriveling through better retention of their natural moisture. Commercially prepared wax mixtures sometimes contain coloring materials also that are intended to add to the appearance of the waxed vegetable. Likewise some commercial waxes contain sprout-prevention substances and fungicidal materials, such as borax, that help to preserve market quality. On a few vegetables, such as green tomatoes intended for long-distance shipment, wax coatings act as lubricants to reduce surface scarring and chaffing.

Fairly thick wax coatings affect the respiration of the product considerably by slowing down the intake of oxygen and the escape of carbon dioxide. With vegetables, however, coatings heavy enough to slow down the escape of carbon dioxide are likely to be obtained only by the melted dip method (page 8) or by painting the stem scars of such fruits as tomatoes (page 12).

Types of Waxing

Commercial wax processes may be classified into eight types according to the materials and equipment used.

1. Dipping in ordinary wax emulsions, the so-called water waxes

Emulsions or water waxes are mixtures of water and waxes made possible by the use of emulsifying agents, such as soaps, detergents, and other materials. Several types of waxes are usually included in these mixtures. One of the most used waxes is carnauba, a vegetable wax obtained from the surface of a Brazilian palm tree. This wax has a high melting point and is the hardest natural wax in commerce. When added to other waxes it increases the melting point, the hardness, the toughness, and the lustre of the mixture, while at the same time it reduces the tendency toward stickiness and plasticity. Occasionally candelilla and ourcury waxes, which have somewhat similar characteristics, are substituted for carnauba. Paraffin waxes are also ingredients of most

wax mixtures. These waxes are the ones commonly used for the manufacture of candles. The paraffins are included in vegetable waxing to control water loss and shrinkage.

Some waxes are manufactured in concentrated forms containing 50 per cent or more of wax solids. These waxes are intended for dip waxing and are diluted to 6 to 10 percent wax solids. This range is generally the proper concentration for application to freshly washed and wet vegetables. Such concentrated waxes should not be diluted more than the directions on the label indicate because the wax tends to roll up and spread unevenly if the emulsifying agent becomes too thin. A typical wax formula[1] of this type is the following.

Materials	*Ounces*
1. Carnauba wax	121
Oleic acid	37
2. Triethanolamine	22
Water	56
3. Paraffin wax	48

Both items 1 and 2 are heated to 194° F. and combined with stirring. A clear jelly-like material results which must be kept at 194° F. and the paraffin added. Water heated to 194° F. is then stirred into the mixture to make 10 gallons. This dilution contains approximately 14 percent wax solids.

Many water waxes, however, are sold in the concentrations in which they are to be applied. These wax mixtures should never be thinned because the water and wax may separate. They should be applied as they come from the can or drum. Therefore, for best results, labels on commercial wax mixtures should be read carefully and followed.

A new self-polishing fungicidal water wax has been developed recently by W. F. Newhall and W. Grierson for use on citrus fruits. This wax mixture is composed entirely of synthetic materials and requires little machinery for its application; a mechanical dip is enough. A complete report on the performance of this wax is given in *The Proceedings of the American Society for Horticultural Science* (Volume 66). The information in the following paragraphs is taken from this article.

This wax has not been used on vegetables; but because of its similar characteristics to vegetable waxes it should be readily adaptable. It may be desirable to reduce the amount of Dowicide A by one half for a tender vegetable.

The procedure for making this water wax is as follows. A 15 per cent Petronauba "C" emulsion is prepared from the materials listed in table 1.

The Petronauba "C" and oleic acid (part A) are melted and mixed. The mixture is heated to a temperature of 205° to 210° F. and maintained within this temperature range for the remainder of the procedure in making the Petronauba "C" emulsion. The morpholine and water mixture (part B) is made and added to part A slow-

[1]U.S. Patents 1,943,468 and 2,057,413

Table 1. Petronauba "C" emulsion. (15 per cent wax solids)

Part	Material	Weight
A	Petronauba "C"	68.7 pounds (15 per cent)
	Oleic acid	9.2 pounds (2 per cent)
B	Morpholine	7.9 pounds (1.73 per cent)
	Water	15.9 pounds (3.47 per cent)
C	Ammonia (28 per cent)	3.3 pounds (.72 per cent)
	Water	15.9 pounds (3.47 per cent)
D	Water	337.2 pounds (73.6 per cent)

ly with vigorous stirring. Ammonia and water (part C) are mixed and added to the mixture of parts A and B with continuous and vigorous stirring. If properly combined, these three parts should form a clear, dark viscous jelly. Water (part D) is heated to 210° F. and added slowly in the required amount with vigorous stirring. The water should be so added that long white streaks do not form at the point of contact. When the required quantity of hot water has been added, the mixture is stirred continuously and allowed to cool to room temperature. The final Petronaube "C" emulsion should be a clear almost transparent material of amber color.

To this prepared emulsion, designated part "E" in table 2, is added the materials labelled *F* and *G*.

The Dowicide A, hexamine, and water (part G) are mixed at room temperature to form a slightly turbid solution. Part F (Rhoplex WN-80) is added to part E (the Petronauba "C" emulsion) with vigorous stirring. This mixture is then added to part G (the Dowicide-Hexamine mixture) with vigorous stirring to form the final fluid wax mixture. If blended properly, the mixture should be a milky white emulsion.

Table 2. Fungicidal water-wax No. 101A (12 per cent wax-resin solids)

Part	Material	Weight
E	Petronauba "C" Emulsion (15 per cent wax solids)	458.1 pounds
F	Rhoplex WN-80 (40 per cent solids)	171.7 pounds
G	Dowicide A	11.4 pounds
	Hexamine	5.7 pounds
	Water	515.4 pounds

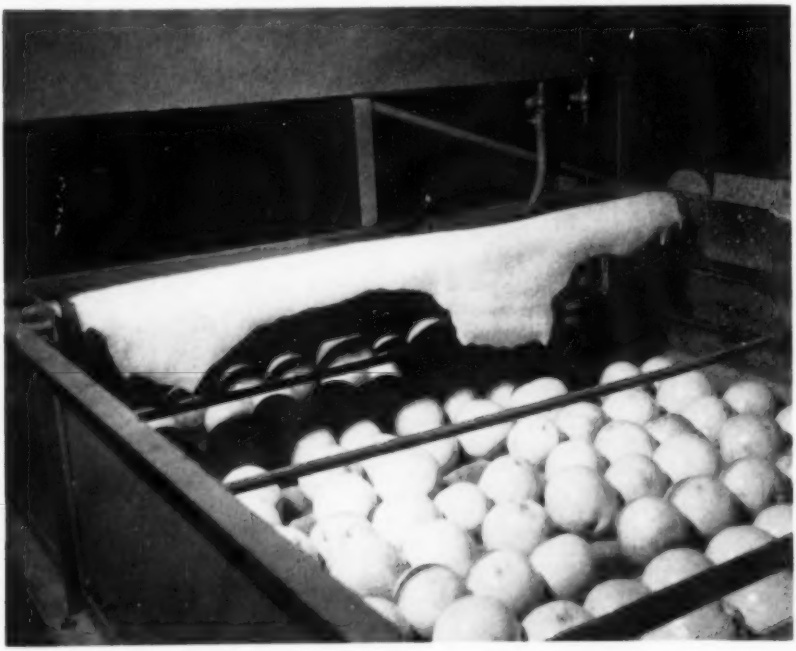
Treating vegetables with water waxes may be done on a small scale by dipping them, basketful by basketful, into a small tub or tank containing the preparation and then letting the produce drain and dry. The water evaporates and leaves a deposit of wax particles and emusifying agent on the surface of the vegetables in a very thin film. Machinery is available also which makes washing, partial drying, and dipping a continuous operation.

The chief objections to the dipping method with emulsion waxes are that the waxes tend to become contaminated with decay organisms and dirt that adheres to the vegetables, or the mixture tends to become diluted with the continued addition of wet produce. Where considerable quantities of vegetables are to be waxed, it is usually better to use one of the methods described hereafter, since these methods are not affected by undesirable dilution and contamination nearly so much as in the dip method. In the dip method, the wax mixture should be changed frequently.

2. Foam waxing

Emulsions with an added foaming agent are used in special waxing machines (figure 1). The emulsion is agitated into a foam which is dropped onto the vegetables as they move through the machine on rollers. Cloth

Figure 1. Foam dropping from an agitator in a foam-waxing machine
Photo from S. C. Johnson and Son, Inc.



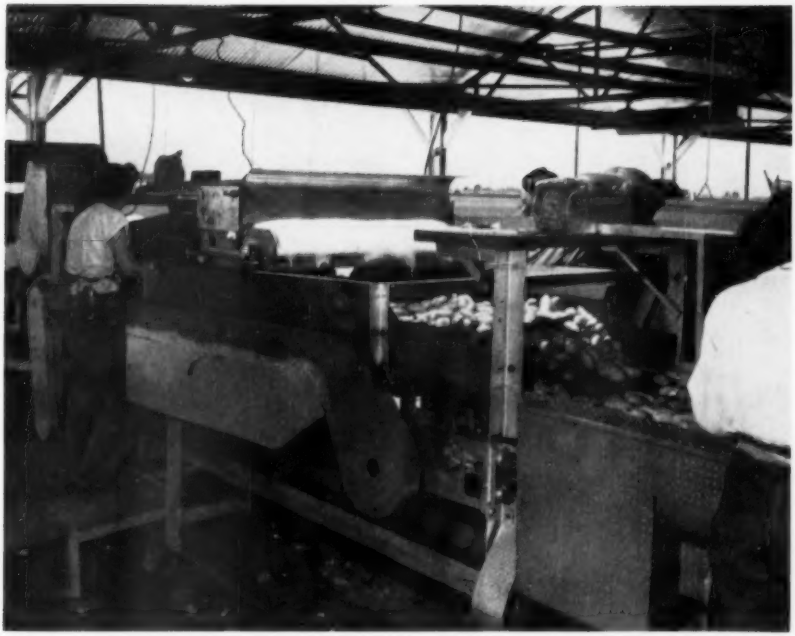


Photo from S. C. Johnson and Son, Inc.

Figure 2. Potatoes passing through a foam waxer

flaps or roller brushes distribute the wax thoroughly over the vegetables and at the same time polish them.

Very little water is put on the vegetables in the foam-waxing process; so they are practically dry when they leave the machine. This method avoids the contamination and uncontrolled dilution encountered in the dipping procedure. Potatoes being waxed on a foam waxer are shown in figure 2.

3. Spray waxing with emulsions

Wax emulsions that stand much pressure without breaking down are now available commercially. Cucumbers and potatoes are waxed with an emulsion applied by spraying at the relatively low pressure of 10 to 20 pounds. For reasons of economy, the equipment using these low pressures has a recovery well and recirculates the excess emulsion. In a recirculating system, however, the objections of contamination and dilution are the same as in the dip method. The well on these machines is of relatively small capacity, however, so that it requires frequent filling. Dilution and contamination are thus controlled to some extent.

Equipment that applies emulsion waxes at the relatively high pressures

of 75 to 125 pounds is also available. This equipment is much more efficient than the low pressure type and so needs no recovery well. Dilution and contamination are not problems. Up to the present time this equipment has been used on citrus fruits only, but should be readily adaptable to vegetable crops. These emulsions or water waxes frequently contain dyes and special mixtures suitable for certain vegetables; therefore it is usually better to obtain the particular type of wax mixture for the kind of vegetable being waxed. For best results, the surface of the vegetable should be clean; usually it is not necessary for it to be completely dried. In this type of operation the excess water is removed by rolling the vegetables over a series of sponge roller dryers faced with Turkish towel material before it enters the waxing machine.

4. Spray waxing with hydrocarbon waxes

In this second spray method, the wax mixture contains a highly purified liquid hydrocarbon solvent. Upon application, the solvent evaporates quickly from the surface of the vegtable and leaves a thin coating of wax. These wax mixtures, like the water waxes, are made in special types. The amount of wax varies in each mixture depending upon whether it is intended for use on relatively smooth surfaces, such as those of tomatoes or peppers, or on rough surfaces, such as those of canteloupes.

Before the solvent waxes are applied, the surfaces of the vegetable must be absolutely clean and thoroughly dry. For this reason, a washer and a heat or air-blast dryer are usually included in the assembly line with a solvent spray waxer. The spray applications are made in a completely enclosed chamber on the machine as shown in figure 3. A blower removes the fumes of the evaporating solvent from the machine and the packing shed.

5. Drip of melted wax, or wax and non-volatile mineral-oil mixtures

Some machines use wax mixtures that are solids, paste, or very thick liquids at ordinary temperatures but become fluid when heated by an electric heating element. Usually these waxes contain solvent materials with moderately slow drying qualities. The wax is dripped onto rotating brushes that spread it over the surface of the vegetables and polish them at the same time. Various methods are used to regulate the amount of drip.

In one method, a metal roller revolving in a container of liquid wax picks up some of the wax and transfers it to series of metal rods riding on top of the roller. The melted wax runs down the rods and drips onto the applicator brush. The whole mechanism is enclosed in a hood equipped with several electric light bulbs which furnish the necessary heat to keep the wax mixture liquid. Such a mechanism with the hood open is shown in figure 4. In operation, the hood is closed.

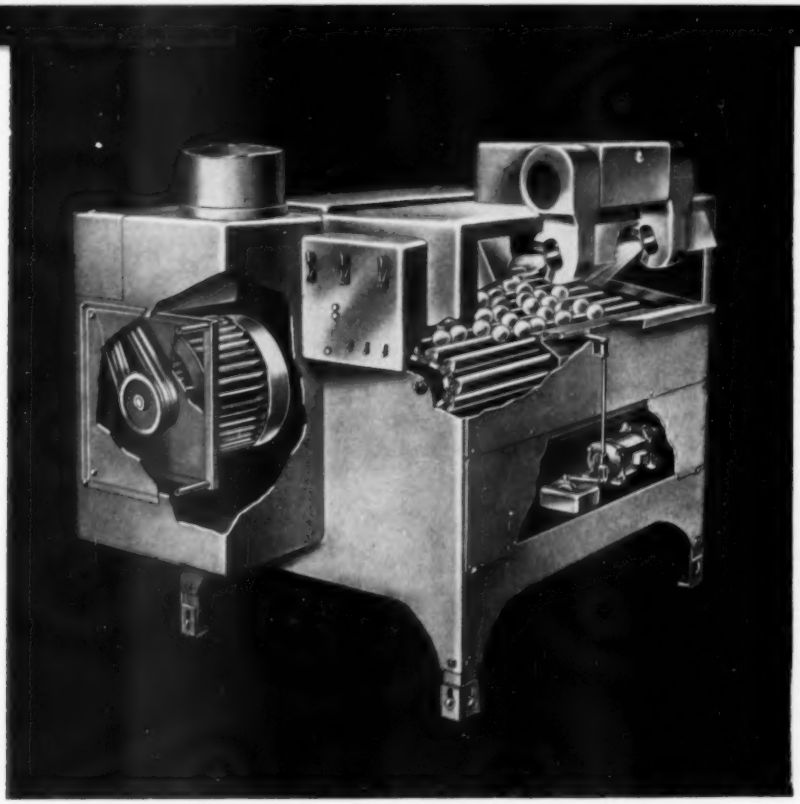
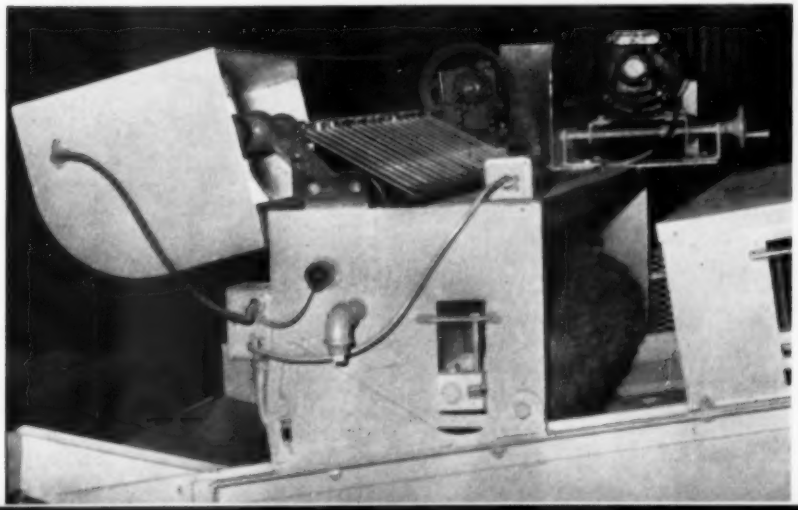


Photo from Food Machinery and Chemical Corporation

Figure 3. Solvent-spray waxing machine showing spray being applied and the blower fan for removing fumes of evaporating solvent

Figure 4. A drip waxer showing pick-up roller, drip rods, rotating brush, and heating element

Photo from American Machinery Company



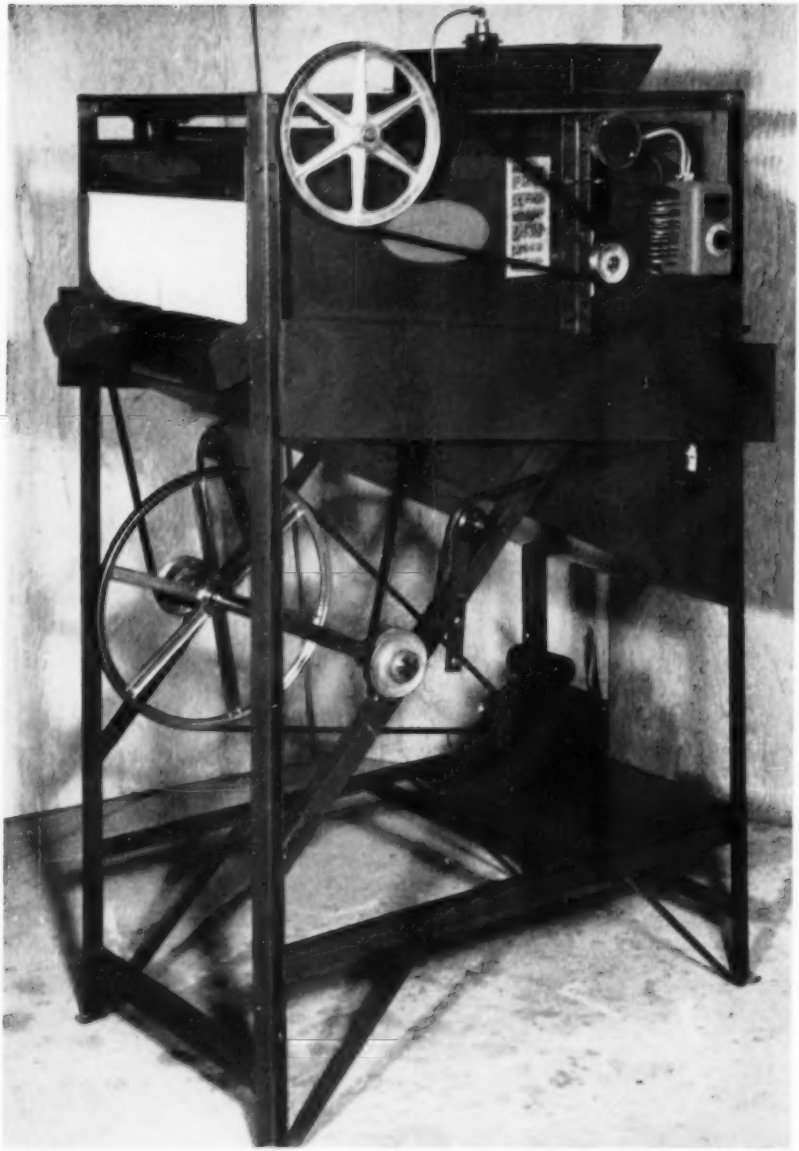


Photo from Lobee Pump and Machinery Company

Figure 5. A drip-type waxing machine. The waxing pan on top contains also a heating unit and a metering device

In another type of drip waxing machine, a very thick mixture is heated to flow freely and is metered out as a drip onto rotating brushes. This same machine, shown in figure 5, can be used also to apply liquid emulsions that do not require pre-heating. The type of vegetable determines which type of wax to use. A farm-size combination washer, sponge dryer, and drip waxer for small operations is shown in figure 6.

6. Application of solid cake wax

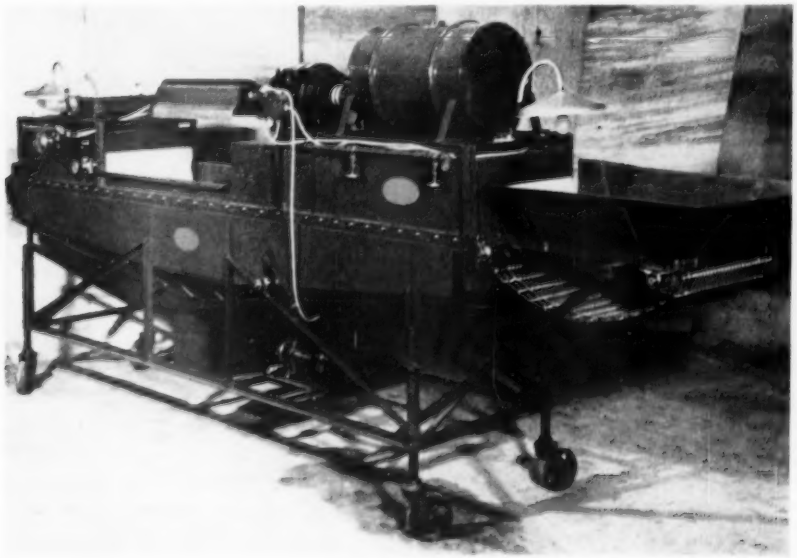
Application of solid cake wax is similar to drip application of melted wax. Special machinery is required for commercial application. Cake wax, consisting usually of 5 to 15 per cent carnauba wax in paraffin wax, is fed against rapidly rotating buffing wheels placed over hairbrush polishers. As the wax is buffed from the cake, it becomes soft and adheres readily to the surface of the vegetables. The vegetables are waxed and polished at the same time.

7. Dipping in melted paraffin

Dipping in melted paraffin provides a coating of wax usually many times as thick as the film resulting from the other types of waxing already mentioned. It is a method that can be adapted for use with limited equipment, but one that requires more care and experience on the part of the operator than do most other methods of waxing. This process, developed primarily in the Province of Ontario for

Figure 6. Small-size combination washer, sponge dryer, and drip waxer for small operations

Photo from Lobee Pump and Machinery Company



rutabagas, is commonly called the *Canadian Process*. It is described in detail in a mimeographed leaflet available from the Ontario Agricultural College, Guelph, Ontario, Canada. The following statements are based mainly on that material.

Any product to be paraffin waxed must be well washed and then completely dried. The temperature of the melted wax is well above that of boiling water; so any free water on the surface of the vegetable may form steam pockets or blisters under the wax. Poor drying of roots is the most common source of failure in hot paraffin waxing.

Generally, crude scale wax is used for waxing rutabagas. This wax, not being completely refined, contains about 3 per cent mineral oil. When pure refined paraffin is used, from 2 to 5 per cent mineral oil, vaseline, or beeswax is added; otherwise the coating is too brittle. In practice, a small quantity, usually not more than 1 or 2 percent, of rosin is generally added to the melted paraffin, because paraffin wax alone is extremely slow setting and rather greasy. Rosin sets rapidly and is adhesive and sticky. Together, however, they react, one with another, so that the slow-setting properties of paraffin wax are modified and there is a substantial reduction in greasiness, while the adhesiveness of the rosin is greatly reduced.

The wax mixture is melted in a metal container, usually by steam, and then permitted to flow into a steam-heated waxing machine as needed. In this way the temperature of the wax in the waxing machine is not materially lowered.

Best results are obtained if the wax is held at 260° F. The safe limits of temperature are from 250° to 270° F. When the wax is too cool, the coating on the root is too heavy, too much wax is used per bushel of roots, and the appearance of the finished root is dull, rough, and unsatisfactory. On the other hand, if the temperature of the wax is too high, the root is burned and made unsightly, and it soon decays.

"Large scale operators find it profitable to use various types of machinery in the processing of rutabagas. Many of them employ mechanical carriers and elevators to transfer the roots from one point to another. Most processors also use mechanical washing machines as well as machines for dipping the root in wax. The rutabagas must be completely immersed in the wax for approximately *one second*. Too long an exposure to the wax will burn the root."

From $\frac{1}{2}$ to $\frac{3}{4}$ pound of paraffin is needed per bushel of large rutabagas and much more for smaller ones, which have a large surface area per bushel.

8. Waxing stem scars of tomatoes

Research has shown that waxing the stem scars of tomatoes with melted paraffin, or with mixtures of paraffin, beeswax, and mineral oil effectively delays ripening and color formation of mature green tomatoes. Waxing the entire surface of the tomato with

the exception of the stem scar has no appreciable effect on the ripening process. Evidence indicates that carbon dioxide moves from the fruit through the stem scar area. Sealing this area with wax causes an accumulation of carbon dioxide in the fruit and this accumulation delays ripening and color formation. This process has been used commercially on a small scale. Materials and equipment cost little, but much labor as well as good judgment of the mature green condition in tomatoes, is required. Properly waxed tomatoes can be held in storage for several weeks after the last killing frost.

Vegetables Commonly Waxed

It is a commercial practice to wax *tomatoes* and *peppers* by one of the processes applying a very thin coating, especially those shipped from the South and West. This provides some surface lubrication which not only reduces chaffing in transit but prevents shrinkage. Many large buyers now require all *cucumbers* to be waxed whether produced locally or shipped-in. Shelf life of this crop is greatly extended and the shriveling of ends is kept to a minimum. Nearly all rutabagas in the market are paraffin waxed.

Potatoes and *sweet potatoes* are fairly commonly waxed, sometimes with colored waxes for the red-skinned varieties. *Cantaloupes* are fairly commonly waxed to prevent pick-up of moisture as well as loss of moisture.

Other vegetables such as *carrots, parsnips, eggplants,* and *small summer squashes* are waxed occasionally.

Effects of Different Types of Waxing

The coating of wax applied by all methods except the melted paraffin dip and the scar-painting is so thin that it is not necessary to remove it before the vegetable is cooked or eaten raw. These methods are not so effective, however, in the prevention of moisture loss from the product (shrinkage control) as are the hot paraffin methods. For example, in one experiment fresh carrots treated with an emulsion of wax lost 14 per cent of their original weight when held for six days at 70° F. whereas unwaxed carrots under the same conditions lost 34 per cent. A melted dip waxing could be expected to hold shrinkage to about 2 per cent for this length of time.

Paraffin alone or in mixtures usually contributes more than any other wax to shrinkage control; but its lustre-producing properties are poor. Rutabagas waxed by the melted paraffin dip process are, for example, rather dull, though not so dull as the unwaxed product when its surface has dried out a bit.

Manufacturers of Waxes and Waxing Equipment

Most manufacturing and supplying companies make special wax mixtures which they recommend for different types of vegetables.

These are generally recommended on the basis of their own research and the exact composition of these prepared waxes is usually not public knowledge. Also, as new waxes and other materials become available these prepared mixtures are changed and improved. Therefore, anyone considering adopting the practice of waxing vegetables should consult one or several of the manufacturers or suppliers. The following is a partial list of suppliers of waxes and waxing machinery. This list is included for convenience and neither mention or order of appearance is meant to imply any endorsement by New York State College of Agriculture at Cornell University for the product or the equipment.

*S. C. Johnson and Son, Agricultural Wax Department, Racine, Wisconsin

Food Machinery and Chemical Corporation, Florida Division, Lakeland, Florida

Food Machinery and Chemical Corporation, John Bean Division, Department AF 7, Lansing 4, Michigan or San Jose, California

Franklin Research Company, Wilbur White Division, 5134 Lancaster Avenue, Philadelphia 31, Pennsylvania

*The Dow Chemical Co., Agricultural Chemical Section, Midland, Michigan

Brogdex Company, 1441 West Second Street, Pomona, California

American Machinery Corporation, Orlando, Florida

†Lobee Pump and Machinery Company, Gasport, New York

Waxpak, P.O. Box 4, San Juan, Texas

*Paramount Manufacturing Company, 1615 E. Main Street, Stockton, California

Tripak Machinery Service, Inc., Harlingen, Texas

*Waxes only

†Machinery only

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